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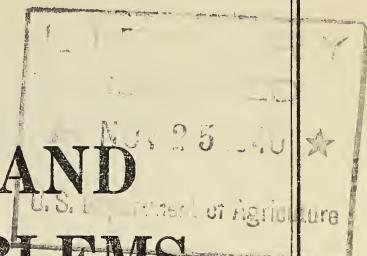
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UNITED STATES DEPARTMENT OF AGRICULTURE

U.S. OFFICE OF EXPERIMENT STATIONS

CONSUMER AND FAMILY PROBLEMS



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Agricultural Experiment Stations, 1939*



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CONSUMER AND FAMILY PROBLEMS

By SYBIL L. SMITH, *Principal Experiment Station Administrator*

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INTRODUCTION

Attention has frequently been called in these reports to the fact that the farm is chiefly a producing agency and the home a consuming agency. It would be undesirable and practically impossible completely to separate agricultural experiment station research dealing with production problems from that dealing with consumption problems. In fact, some of the research is of interest and value both to the producer and the consumer. In this section various contributions of the past year in several different fields will be discussed largely from the viewpoint of the consumer but with full understanding that some of the findings may also be of value to the producer.

First in importance, by virtue of the fact that this report is confined to agricultural experiment station research, is the field of foods. Consumer problems include the selection of foods for quality and nutritive value and their preparation for the table in such a manner as best to preserve the qualities for which they are selected and to bring out to the fullest degree their most desirable characteristics. The preservation of home-produced foods in times of abundance for periods of scarcity is a problem with which the farm homemaker has always had to deal. Now the home canning of fruits and vegetables and even meats is giving way to some extent to the preparation of these foods for frozen storage in lockers. Frozen storage of foods has opened up an entirely new series of problems for those who wish to substitute this method for canning or to use frozen foods as available commercially.

An increasing amount of attention is being paid in experiment station research to human-nutrition problems. Studies of food composition show the amount of various constituents present in different foods; research in nutrition shows the need of these constituents and their availability in different foods. The most significant recent development in nutrition research at the experiment stations has been its extension from work with experimental animals to human beings, among whom students at the land-grant institutions predominate. The problem of food selection for optimum nutrition becomes a vital one to many a homemaker throughout the country when her own daughter writes from college that she is serving as a subject in nutrition-research projects.

The homemaker herself may be participating in an experiment station research project dealing indirectly with nutrition by recording what foods her family has been consuming and the quantity of

each consumed over a period of time. Dietary studies help to solve the many problems involved in the best selection of food at the least expense. The analysis of dietary records shows the good and bad points in family or personal food selection. If such dietary studies can be accompanied, as is the case in several projects to be noted later, by studies of the nutritional status of members of the family or of individuals, the picture is completed. Certain deficiencies in the diet are revealed not only in the diet calculations but also in the condition of the people who have been on the diet in question.

Feeding the family in such a way as to promote optimal nutrition is not the only concern of the homemaker. She has more concrete problems in the arrangement of her house, particularly the kitchen, and in the selection of equipment and furnishings. She has her family to clothe, with the problem of deciding what garments to make herself and what to buy ready-made. For both home-made and ready-made garments and household furnishings there is many a problem in selection for satisfaction and durability. The chief burden of textile and clothing selection generally falls on the housewife; equipment-selection and housing-arrangement problems she is quite likely to share with her husband, and when it comes to getting the perspective on all the problems that make up family living the two must work together, and in fact bring into the discussion all of the family members old enough to take any responsibility. Family economics and family relationships are the terms used in research to denote the problems of management of the family's material resources and spiritual resources, respectively, which together make up family living.

Under these general items some of the contributions of the year in experiment station research will be discussed as far as possible from the standpoint of the consumer.

FOODS

A generous supply of home-produced foods continued to be emphasized by agents of the Extension Service and the Farm Security Administration of the Department of Agriculture, as well as by research workers who have studied farm-family diets throughout the country, as the best means of solving the problem of providing adequate diets on very limited cash incomes. Vegetables and fruits are of value chiefly for their minerals and vitamins; milk and eggs for minerals and certain vitamins and also for their high quality protein. Meat formerly was valued chiefly for its high-quality protein, but experiment station research within the last year or two has shown that it also furnishes significant amounts of some of the newer vitamins. Each year new facts on food composition are brought to light which are a help in food selection. Some of the experiment station findings of the past year concerning foods which can be home-produced in certain sections of the country and are available on the market almost everywhere are noted below.

SELECTION FOR NUTRITIVE VALUE

Fruits.—With the importance now attached to providing an abundance of vitamin C in the daily diet, the first thought that comes to mind in fruit selection is its vitamin C content. It is a mistake to think that sole reliance should be placed on citrus fruits or even

tomatoes for this vitamin. Certain other fruits, berries, and vegetables grown in the home orchard and garden may be counted on to furnish a good share of the family's daily requirement of this very essential vitamin. A few fruits are doubly valuable as being also good sources of vitamin A.

The apple has marked varietal and possibly geographical differences in its content of vitamin C. Virginia-grown apples were found by the Virginia station to have such varietal differences in their vitamin C content that the richest variety tested had three times as much of the vitamin per apple as the poorest variety. Black Twig ranked highest, followed in descending order by Winter Banana, Ben Davis, Winesap, York Imperial, Northwestern Greening, Stayman Winesap, Red Rome, Arkansas Black, Rome Beauty, Virginia Beauty, Jonathan, Delicious, Senator Oliver, Grimes Golden, and Lowry. According to the Wisconsin station, Jonathan, Winesap, and Delicious grown in the State are all rather poor sources of vitamin C compared with one of their best varieties, the Northern Spy, 1 pound of which has been calculated to furnish as much vitamin C as 3 to 8 pounds of the other three varieties. The station has a new seedling which is even richer in vitamin C than the Northern Spy. Of several varieties of apples recently tested by the Washington station in continuation of earlier work noted in the 1936 report, Esopus Spitzenburg ranked highest followed by Winter Banana, Stayman Winesap, and White Pearmain, which contained only about a third as much vitamin C as Esopus Spitzenburg.

To get the full vitamin C value of apples the peel should not be discarded, for both the Virginia and the Washington stations have reported that the highest concentration of the vitamin is in the peel, which is from three to five times as rich in C as the flesh. Apparently the vitamin is rather unevenly distributed throughout the flesh. The Washington station reports a lower content in the center of the flesh than near the core or peel and the Maine station more of the vitamin on the sunny side than the shaded side of the whole apple. The temperature and duration of storage are considered important factors in preserving or destroying the vitamin C content of apples. The Virginia station reports a loss of nearly half of the original vitamin C content in apples stored for 6 months at 38° F. This means that by spring apples kept under most conditions of home storage will be only half as good a source of vitamin C as when first harvested. To get the most out of apples as a source of vitamin C, varieties should be selected which have been found to be the richest sources of this vitamin, they should be eaten raw, both peel and flesh, and for winter use should be stored just above freezing temperature. Under such conditions, according to the Virginia station, two or three apples a day would cover the body's requirements. However, no one food need be relied on to furnish the entire requirement of vitamin C for, as will be noted later, there is a wide variety of foods which at one season or another can make a good contribution to the day's needs.

The cantaloup is a seasonal fruit which varies considerably in its vitamin C content. Among six Texas-grown varieties or types Hale Best was found by the Texas station to rank highest in vitamin C with a value of 33.3 mg. per 100 gm. and Rocky Ford lowest with a value

of 26.4 mg. per 100 gm. A wider range in values has been reported in a more extensive study at the University of North Carolina where Rocky Ford grown in the State gave the highest average value, 32.6 mg. per 100 gm., with Hale Best considerably lower, 25.9 mg. per 100 gm. Different specimens of a single variety, Rocky Ford, gave values ranging from 21.6 to 38.2 mg. per 100 gm., showing that factors other than variety are partly responsible for differences in vitamin C content. In general, overripe melons were less rich in the vitamin than the same variety at the best stage for eating. North Carolina investigators estimate that one-half of a cantaloup of average size may supply 40 mg. of vitamin C, an amount which probably represents about the minimum day's requirement or about half a generous allowance of this vitamin.

Among fruits that until recently have received little attention as a source of vitamins is the common currant used so extensively in jelly making. Fresh, ordinary red currants and currant juice are reported by the Massachusetts station to have a high content of vitamin C and also to contain about 180 International Units of carotene (the plant source of vitamin A) per ounce. Persimmons have been found by the Texas station to be unusually rich in vitamin C, with a value of 43 mg. per 100 gm. in comparison with from 29 to 46 mg. per 100 gm. for 6 varieties of oranges, 7 to 37 mg. for 6 varieties of cantaloups, and from about 3 to 9 mg. per 100 gm. for 9 varieties of watermelons as tested by the station. Although watermelons are quite low in vitamin C as compared with many other fruits, the amount in an ordinary serving may easily exceed that of other fruits usually thought of as furnishing considerably more of the vitamin. Among other fruits placed by the Texas station in the same class as the watermelon in contributing less than 10 mg. of vitamin C per 100 gm. are peaches, pears, plums, and pomegranates. None of these, however, would be eaten in as large amounts at a single serving as the watermelon and consequently should be considered much poorer practical sources of the vitamin.

Values reported by the Massachusetts station for the vitamin-A content of a number of frozen fruits show quite strikingly what fruits are good and what poor sources of the vitamin: Dried prune pulp 2,600, yellow peaches 2,000, strawberries 740, red raspberries 520, Youngberries 460, blueberries 110, grated pineapple 55, apples 36, and cranberries 20 International Units of vitamin A per 100 gm. The use of frozen prune pulp or frozen yellow peaches in desserts would make a good contribution to the day's requirement of vitamin A, tentatively estimated to be from 3,000 to 4,000 International Units per day for an adult and from 6,000 to 8,000 for a growing child. Frozen raspberries, one of the most satisfactory of frozen berries for appearance and palatability, are a good source of vitamin C as well as furnishing a fairly large amount of vitamin A. The vitamin C in frozen raspberries, moreover, has been found by the Washington station to be utilized just as well by human subjects as pure vitamin C.

Vegetables.—Certain vegetables have sufficient vitamin C to furnish an appreciable portion of the day's requirements and one or two are among the richest sources of this vitamin. Some yellow vegetables are very good sources of vitamin A. Green leafy vegetables are excellent sources of vitamin A and good sources of calcium and iron.

Seeds and legumes are very good sources of iron and relatively rich in vitamin B₁. Some recent experiment station findings on the vitamin and mineral content of vegetables are noted below.

Asparagus was found by the Massachusetts station to contain 66 International Units of vitamin B₁ per 100 gm. and to retain about 74 percent of the value on quick freezing and 71 percent in canning. (While the vitamin B₁ requirement for man is not yet known with certainty, estimates are placed at from 200 to 400 International Units per man per day.) Frozen asparagus was given a low value for vitamin A, 700 International Units per 100 gm., by the same station. Possibly white rather than green asparagus was used in the tests on which this value was based.

Attention has recently been called by the New Mexico station to the calico bean as a rich source of vitamin B₁ and worthy of more attention. The calico bean, otherwise known as the Manchurian pinto or the Spotted Red Mexican bean, is a red bean with white splotches. It is a little larger, and is said to cook more quickly than the pinto bean. The latter, formerly reported by the New Mexico station to be an excellent source of vitamin B₁, has now been found by the station to be a good source, in the cooked state, of riboflavin and vitamin B₆. The pinto bean like other legumes was also found to be a good source of iron and copper for hemoglobin regeneration. Green lima beans were found by the Massachusetts station to contain practically the same quantity of vitamin B₁, 65 International Units per 100 gm., as asparagus (noted above) but to retain much less, only 46 percent, of the vitamin on freezing and still less, 25 percent, on canning. The frozen beans were, however, a much better source of vitamin A, 1,800 International Units per 100 gm., than the asparagus tested by this station. Frozen wax snap beans were somewhat lower and green snap beans very much higher in vitamin A than frozen lima beans, the values reported being 1,240 International Units per 100 gm. for the wax and 5,400 International Units per 100 gm. for the green snap beans.

A recent bulletin (No. 373) of the Montana station contains information on the content of various vitamins in green snap beans of the Burpee Stringless Green Pod variety when cooked or canned or stored. According to this report an average serving of 70 gm. (a little over 2 ounces) of freshly cooked green snap beans would supply 840 International Units of vitamin A, 23 International Units of vitamin B₁, and from 7 to 12 mg. of vitamin C. A serving of the same beans canned by pressure-cooker methods, stored 6 months, and reheated before serving would furnish 700 International Units of vitamin A, 14 International Units of vitamin B₁, and only 3 mg. of vitamin C. The very low figure for vitamin C in the canned beans was traced to losses during the first 2 months of storage. This was true of both glass- and tin-canned products, but on longer storage the losses continued at a slow rate in the glass but not in the tin. These findings indicate that green snap beans are a valuable vegetable for the home garden in that when freshly cooked they make a very good contribution to the day's requirement of at least three vitamins, and after being canned and stored for several months still contain appreciable quantities of two of these vitamins.

The vitamin C content of snap beans has been found by the New York State station to be affected by a number of factors. Of 13 varieties tested, the vitamin C values ranged from 24 mg. per 100 gm. for Tendergreen to 9 mg. per 100 gm. for Georgian. These differences are probably associated largely with the ratio of seeds to pods, as the seeds are much richer in vitamin C than the pods. The Red Kidney and White Pea varieties, which are ordinarily harvested as seed beans, were among the highest in C content (28 and 22 mg. per 100 cc.) in the green snap bean stage. The vitamin C content of the seeds increased with growth of the pod while that of the pod itself decreased rapidly at first and then remained about constant. Consequently, overmature snap beans tend to be richer in C than beans at the right stage of maturity, particularly in the large-seeded varieties. Storage tests showed that snap beans lose their vitamin C rapidly at all temperatures although somewhat more slowly just above freezing than at room temperature. As an example, Kentucky Wonder lost 7 percent of its vitamin C in 24 hours at a temperature just above freezing and 41 percent during the same period at room temperature. After 2 days the corresponding losses were 19 and 47 percent and after 6 days 53 and 78 percent, respectively. These losses can be prevented in home-grown beans by picking them just before they are to be cooked or canned.

Soybeans vary widely in their vitamin A content and, according to the Alabama station, are a much better source of this vitamin at the stage of eating as green beans than after they have matured. Mature soybeans were also found by the station to lose their vitamin A very rapidly, as much as 50 percent in 2 weeks, on weathering. Consequently, if home-grown soybeans are to be relied on as a practical source of vitamin A in the diet, they should be used while young and green and the surplus canned at this stage, or if the mature beans are preferred, they should be harvested early and not be allowed to stay on the field.

Broccoli, as might be expected from its deep-green color, was found by the Massachusetts station to be quite rich in vitamin A, frozen broccoli furnishing 4,680 International Units of vitamin A per 100 gm., or nearly as much as green snap beans. The station also reported that broccoli loses its vitamin C to an even greater extent than snap beans on standing after harvesting, over 35 percent disappearing during standing for 3 days at room temperature. Commercially frozen broccoli sampled and tested over periods of several months gave a vitamin C content of from 57 to 124 mg. per 100 gm. for the buds and from 110 to 149 mg. for the stem. Corresponding values for fresh broccoli were 67 to 122 mg. per 100 gm. These values show broccoli to be such an excellent source of vitamin C in the fresh and frozen state that, even with the customary losses on cooking, a serving would make a good contribution to the vitamin C content of a meal.

Raw cabbage is an excellent source of vitamin C. In a miscellaneous series of tests the Texas station ranked cabbage, vitamin C value 130 mg. per 100 gm., along with mustard greens 165, peppers 104 to 281, and turnip greens 162 mg. vitamin C per 100 gm. in the group of vegetables of highest vitamin C content. In some localities cabbage is preserved on the farm as sauerkraut for winter use. There has been lack of agreement as to losses of vitamin C in the conversion

of cabbage into sauerkraut and its preservation in this form. According to recent studies at the New York State station, loss of vitamin C in sauerkraut is not associated with the fermentation process but with subsequent losses of carbon dioxide formed during fermentation. This being the case, the less the manipulation, such as would occur during the mixing and preheating necessary in canning sauerkraut in small containers, the greater the likelihood of preserving the vitamin C content. Consequently, the station recommends packing sauerkraut in tanks or barrels rather than canning, and storing at room rather than refrigeration temperature in order to encourage more fermentation with increased production of carbon dioxide. On the other hand, the Wisconsin station suggests canning sauerkraut in half-pint jars. The Massachusetts station has called attention to the value of sauerkraut as a source of vitamin C, stating that tank sauerkraut contains twice as much of the vitamin as tomato or pineapple juice.

Carrots have the reputation of being a rich source of vitamin A, but this depends on the variety and also on freshness. A high value, 3,500 International Units per 100 gm., was reported by the Massachusetts station for frozen carrots (variety not named). The Tennessee station reports a much lower vitamin A value, a little less than 800 International Units per 100 gm., for raw Chantenay carrots at the time of harvesting and 370 Units after 5 months' storage. Chantenay carrots were reported by the New York State and (Cornell) stations to contain from 4.4 to 6.9 mg. of vitamin C per 100 gm. when raw and to retain about 56 percent of the vitamin in the carrots and 33 percent in the cooking water on boiling for 15 minutes. Thinly sliced carrots lost only 14 percent of their vitamin C content on steaming for 20 minutes. Compared with many other foods, carrots are too low in their vitamin C to cause great concern in losses on cooking. The losses in vitamin A on storing are of greater practical importance. It would seem wiser to preserve home-grown carrots in the young tender stage by canning or frozen-locker storage than to harvest them late for winter storage.

Green peas are relatively rich in vitamins A, B, and C and seem to be particularly adapted to preservation by frozen storage. A vitamin A value for frozen peas of 4,800 International Units per 100 gm. was reported by the Massachusetts station. Green peas thus rank between green snap beans and broccoli in vitamin A. In their content of vitamin B₁ green peas were found by the station to be richer than the other three vegetables tested—asparagus, lima beans, and spinach—and also to retain as much or more of the vitamin on freezing and canning. The values reported were 148 International Units per 100 gm. in the raw state with 97 percent retention on freezing and 66 percent on canning. Consistent values for the vitamin C content of fresh and frozen green peas have been reported by the Massachusetts, New York State, and Washington stations. The Massachusetts values were from 25 to 28 mg. per 100 gm. for the fresh unfrozen and 15 to 22 mg. per 100 gm. for the frozen peas. Values of 25 mg. per 100 gm. for the fresh unfrozen and 18 mg. per 100 gm. for the frozen peas were reported by the New York State station, which also noted a loss of about 38 percent during the blanching, chilling, and packaging of the peas preparatory to freezing. Frozen peas cooked directly after removal from frozen storage

retained 59 percent of their vitamin C in the peas and 39 percent in the water, very little actual destruction of the vitamin thus taking place.

The Washington station in cooperation with the Seattle Frozen Pack Laboratory of the Department (B.C. and S.) is carrying on extensive studies of the effect of variety, size, and different processing methods on the content of vitamins A and C in peas grown in the Northwest for the rapidly expanding frozen-food industry. The mean vitamin C content of nine varieties of peas ranged from 11.3 to 29.4 mg. per 100 gm. Frozen peas of the Telephone variety, which had a vitamin C content of 17 mg. per 100 gm. immediately after thawing, showed losses amounting to almost 16 percent after standing for 30 minutes and 27.1 percent after 60 minutes. Storage of the thawed peas in a refrigerator at 4.5° C. did not prevent vitamin C losses, which amounted to about 25 percent in 24 hours. These values point to the wisdom of not allowing frozen peas to thaw before cooking.

Peppers of different varieties appear to be exceptionally rich in vitamin C. Values of 104 to 281 mg. per 100 gm. are reported by the Texas station for peppers of undesignated varieties. The Georgia station has made an extensive study of the vitamin C content of the Perfection pimiento which is widely grown in the State and canned on a large scale commercially. Values of from 167 to 314 mg. per 100 gm. of the fresh pimiento were obtained in the 1937 season and from 128 to 252 mg. per 100 gm. in the 1938 season. Pimientos canned in 1936 had a vitamin C content of 137 mg. per 100 gm. in 1936, 110 mg. in 1937, and 84 mg. per 100 gm. in 1938, thus showing that the canning itself is not so destructive of vitamin C as long periods of storage of the canned product. The pepper as a source of vitamin C affords a good contrast with the watermelon in that the former represents a food high in vitamin C but which is chiefly consumed in small amounts (as in salads) while the latter is a food relatively low in vitamin C but customarily served in large portions. Each may make a decided contribution to the vitamin C content of a single meal.

Potatoes are likewise low in vitamin C, but in low-cost diets may make the only contribution of importance to the diet, depending on the frequency with which they are used and the way in which they are cooked as well as upon other factors not as easily controlled by the housewife, such as variety, maturity, and length of storage.

The effects of a number of these factors have been studied by the Massachusetts station. Varietal differences were less than differences found in a single variety. The average vitamin C value for six samples of Irish Cobblers from different localities was 13.1 mg. per 100 gm., of Katahdins 12.5, of Green Mountains 11.7, and of Rural Russets 11 mg. per 100 gm. The vitamin C content of potatoes of a single crop was found to remain rather constant from the first digging until the potatoes had fully matured, but after digging losses amounting to as much as 50 percent occurred on winter storage, an observation also made by the New York (Cornell) station. All methods of cooking tested by the Massachusetts station resulted in losses, amounting to about 40 percent with either baking or boiling. Boiled potatoes held at 40° F. for 24 hours retained approximately 80 percent of their vitamin C content, and on reheating retained somewhat more of the vitamin if fried than if creamed. Boiling in salted

water preserved the vitamin to a somewhat greater extent than boiling in unsalted water. The importance of potatoes as a source of vitamin C in low-cost diets was emphasized by the Massachusetts investigators through calculations of the relative quantities and cost at prevailing prices of enough oranges, tomatoes, and potatoes to furnish a 50-mg. allowance of vitamin C, this amount representing a conservative estimate of the day's requirement of an adult. These values were given as 4.5 ounces of oranges at a total cost of 3.5 cents, 10 ounces of tomatoes at a cost of 4 cents, and 14 ounces of potatoes (or three potatoes of ordinary size) at a total cost of 1.4 cents. Although these figures should not be accepted too literally because of the many factors affecting the vitamin C content of the foods, particularly the potato, they do show that the ordinary white potato, if cooked properly and served frequently, may at certain seasons supply a large proportion of the vitamin C requirement.

Frozen pumpkins and squash ranked high in vitamin A in the series of studies by the Massachusetts station, already noted, with a value of 18,400 International Units per 100 gm. exceeded only, among the vegetables tested, by spinach, with a value of 30,000 International Units per 100 gm. With this high initial value and the known stability of vitamin A to heat, it may be assumed that a slice of pumpkin or squash pie will make a good contribution towards the day's quota of vitamin A.

The high vitamin A content of frozen spinach has been noted in the preceding paragraph. In vitamin B₁ content the Massachusetts station found spinach to be lower than asparagus, peas, or lima beans (containing only 40 International Units per 100 gm.), but to retain 92 percent of the vitamin on freezing, and 87 percent on canning. For vitamin C, values ranging from 14 to 68 mg. per 100 gm. were earlier reported from Massachusetts with a 47-percent loss on standing for 3 days at room temperature. Samples of frozen spinach gave vitamin C values of 2 to 86 mg. per 100 gm. More recently the station has made a systematic analysis of 10 samples of spinach given various treatments. The raw spinach varied in vitamin C content from 58 to 108 mg. per 100 gm. with the high average of 84 mg. per 100 gm. When cooked in steam this average value dropped to 56, cooked in water 26, frozen 47, frozen cooked in water 28.5, and canned 27.5 mg. per 100 gm. Using the cooking water in all cases would increase the available vitamin C, for a considerable portion is dissolved in the water rather than destroyed. Perfectly fresh spinach, steam cooked in the smallest possible amount of water which is not discarded would seem to be a practical source of vitamin C.

Formerly spinach was highly regarded as a source of calcium but of late it has come into disrepute in this respect, partly as a result of work at the Illinois station. In some experiments in which rats were used as the test animal and the same quantities of calcium were fed as milk and as spinach, it was found that for each 100 mg. of calcium stored in the bodies of the animals on the milk-supplemented diet only 45 mg. was stored on the spinach diet. The calcium in spinach (and also in New Zealand spinach) is in the form of calcium oxalate which the Illinois investigators found to be very poorly utilized. The problem of the utilization of calcium from different vegetable sources has been attacked by the Georgia station by com-

paring the storage of calcium in the bodies of rats receiving skim-milk powder as the sole source of calcium with others on the same diet with half of the calcium of the milk powder substituted by that of dried greens. Turnip greens proved to be nearly as effective as milk, followed in decreasing order by tender greens, collards, and kale, and last by New Zealand spinach which was very poorly utilized.

It is not always safe to make recommendations for human beings on the basis of experimental work with rats. In the case of calcium, the Illinois station has found that human beings are not capable of utilizing calcium as completely as rats. However, the relative effectiveness of different sources of calcium may be the same for rats and human beings. The methods followed in the Georgia study just noted were based on the report of a similar study at the Oregon State College conducted on two human subjects to compare the utilization of calcium from spinach and kale. Here, as in the rat tests, the calcium of kale was utilized to a much greater extent than that of spinach. It is apparent that spinach must give way to some of the other less publicized green leafy vegetables as a source of calcium.

Green leafy and seed vegetables (legumes) are valuable for their iron content although there is now some question as to the relative availability of the iron in different vegetables. In recent work by the Georgia Station vegetables did not fall in exactly the same order for availability of iron when tested chemically and by feeding experiments with rats. By the latter tests black-eyed peas and spinach headed the list of a number of vegetables tested, followed by turnip greens and kale, collards and mustard greens, head lettuce, and finally tender greens and leaf lettuce. These studies were made in the South where turnip greens and collards are the most commonly grown green vegetables but might be used to a much greater extent. As the best means of increasing the low iron content of the diet of many southern families the Mississippi station gives this advice to the housewife—

Serve more green leafy vegetables, raw or cooked (with the pot liquor if cooked) and one leguminous vegetable (black-eyed peas, beans, etc.) every day. A serving of each of these vegetables will furnish most of the iron needed daily by any one member of your family and this will help to prevent anemia and keep them well.

Sweetpotatoes are an important source of vitamin A in the South. This might be easily guessed from the deep-yellow color of the varieties most popular in this section of the country, where the freshly harvested, dry sweetpotato is considered very poor eating in comparison with a moist and sweeter product after curing. Fortunately, curing and storage increase the vitamin A value of the Porto Rico variety. The Tennessee station reports a vitamin A value of less than 5,600 International Units per 100 gm. at harvest, 5,000 after 4 months' storage, and 8,800 International Units after 8 months' storage. Moreover, these already high values were almost doubled on cooking, the corresponding values for the cooked product being 8,500, 12,400, and 14,700 International Units per 100 gm., respectively. Similar tests on the Nancy Hall variety showed no increase in the vitamin A value on storage. The vitamin A value of the raw Nancy Hall was 2,800 International Units per 100 gm. at harvest,

4,000 International Units per 100 gm. after 4 months' storage, and 2,800 International Units after 8 months' storage. These values were more than doubled on cooking, for the corresponding values for the cooked product were 5,900, 9,500, and 6,700 International Units per 100 gm., respectively.

An increase in vitamin A value on storage and cooking is not characteristic of all yellow vegetables, for the Tennessee station reported no change or slight losses, on storage and cooking, in the vitamin A value of carrots, rutabagas, and Amber Globe turnips.

A root vegetable not common in continental United States but very extensively used in Hawaii is the taro, sometimes known as the dasheen. The Hawaii station reports that taro is an excellent source of calcium as determined by experiments not only on rats but also on human beings.

Last on the list of fruits and vegetables selected for discussion because of recent experiment station research in their nutritive value is the tomato. A publication of special interest to both producers and consumers is a bulletin (No. 354) of the Massachusetts station which summarizes in tabular form data from all available published reports on the vitamin C content of raw, canned, fermented, and dried tomatoes, tomato conserves, and canned tomato juice and reports an extension of the varietal studies noted in the 1937 report (pp. 138, 139) to cover three successive crops of the same varieties and strains. The tomato grower, whether on a commercial or home-garden scale, can learn from this publication what varieties and strains of tomatoes have proved consistently high in vitamin C content. The housewife who depends upon her home-grown tomatoes to supply the family's needs the year around may be glad to know that the Massachusetts investigators found no appreciable differences in the vitamin C content of a number of varieties from the hard-green to the hard-ripe stage, and no losses during 10 days of storage at room temperature after picking. If she puts up her own tomato juice, it may be of help to know that the chief losses in vitamin C apparently take place, not during the preliminary heating and pulping, but later when the juice is being concentrated to prevent separating. A thin juice even if it does separate a little is preferable to a thick juice of even consistency. In commercial canning the separation is usually prevented by homogenizing the juice, a process which the Massachusetts investigators found to have little effect on the vitamin C content.

There has been considerable discussion of late as to the use of glass or tin in canning tomato juice. In the Massachusetts station study samples of juice canned in glass and kept either in the dark or light showed small but continuous losses in vitamin C during a 30-day test period while samples canned in tin showed no losses. The Arkansas station also found that tomato juice preserved in glass containers gave from 10 to 15 percent lower values for vitamin C than samples from the same lot processed in tin. In attempting to explain the difference the Arkansas investigators found that tomato juice processed with a little added iron gave values in the chemical test for vitamin C from two to three times as high as the tomato juice alone, showing that the iron was reacting to the test, giving falsely high values for vitamin C content. On the other hand, when solutions of pure vitamin C in a

dilute acid were heated with and without the addition of metallic tin the losses of the vitamin were much less in the presence than in the absence of tin. They concluded, therefore, that there is less destruction of the vitamin in tomato juice canned in tin than in glass but that extraordinarily high values in tin may be looked upon with suspicion as being due partly to iron which may be present and not entirely to the vitamin.

Meats and meat products.—Formerly meats were valued chiefly for their high-quality protein and were thought to be a very poor source of vitamins. Recently they have assumed new importance through the discovery that certain meats and meat products are practical sources of the vitamins of the B group which are so completely removed from one of their best sources—cereals such as wheat and rice—by modern milling processes. The function of these B vitamins as brought out in recent experiment station research will be discussed in a later section, but it may be of interest to note here that the best known of the group, vitamin B₁, is necessary for the complete digestion and utilization of the starch from which it has been removed in the milling of cereals. There is some reason for the popularity of meat sandwiches, for if they are made with white bread the meat makes up in a small way for the vitamin B₁ deficiency in the bread.

Lean pork is exceptionally high in vitamin B₁, according to the Wisconsin station which has made an extensive study of the distribution of the various B vitamins in meat and meat products. Lean pork was found to contain from 130 to 200 International Units of vitamin B₁ per 100 gm., followed by pork and beef heart with values of 80 and 100, leg of lamb 40, beef round 30, and pork and beef kidneys 8 and 5 and livers 5 and 4 International Units per 100 gm., respectively. The losses of vitamin B₁ from different cuts of meat on cooking were found to be much less with frying than roasting, baking, or stewing. In the opinion of the station, meats, even though used in the diet to the extent of only 7 percent—

are capable of supplying one-third of the human vitamin B₁ needs. When meat such as pork is used, the proportion of the day's requirement thus supplied is correspondingly increased. A pork chop even when fried may supply the total daily requirement of this vitamin.

As for the other vitamins of the B group, the Wisconsin station investigators report that one-tenth of a pound of fresh liver or 1 pound of fresh beef round will furnish the suggested daily requirement of riboflavin, and a quarter of a pound of veal or lean pork the requirement of nicotinic acid, the substance now known to be specific for the prevention and cure of the most characteristic symptoms of pellagra. The superiority of pork over other meats as a source of vitamin B₁, as well as its relatively high content of nicotinic acid, is of significance on the farm, where pork is more often home-produced than are other meats. The higher values of liver than lean meat in riboflavin and nicotinic acid show the importance of using storage and glandular organs as well as muscle meat.

Cereals and cereal products.—The superiority of unmilled as compared with refined cereals in the B vitamins has been referred to above. Unpolished rice has been shown by the Arkansas station to be superior also to polished rice in its proteins as determined by rat-

feeding experiments. The simple change from polished rice to whole or brown rice will do much to improve the diet in the B vitamins and in the quality of the proteins.

Another improvement in the diet which is very easy to bring about if the bread supply is made at home is to include dried milk in the recipe. When bread containing no milk was compared at the Illinois station with bread containing 6 and 12 percent of milk solids by feeding the three types to well-matched young rats, the animals receiving either of the milk breads gained more in length and weight than those receiving the bread made without milk. Their bodies at the end of the experiment also contained more calcium, with those on the 12-percent milk-solids bread definitely superior to those receiving half as much of the milk solids. If commercially made bread is used, it is a good plan to select milk bread, particularly if there are children in the family, for the added nutritive value is worth the small additional cost.

SELECTION FOR QUALITY

The appearance and palatability of foods count for more than their nutritive value in their popularity in the diet. The cooking or culinary quality of certain foods has long been a matter of concern to the housewife who prepares them for the table, and to the producer whose profits depend so much on the quality of the product.

The apple varies as widely in appearance, palatability, and culinary qualities as in vitamin C content, and consequently has received much attention from this standpoint at experiment stations in apple-producing States. The New York (Cornell) station has recently published (Memoir 225) the results of an investigation covering a period of 5 years during which 13 important varieties of New York State apples were tested periodically, and 15 other varieties occasionally, for their cooking properties as well as their flavor and texture both raw and cooked. After many trials the cooking methods finally selected as most satisfactory for retention of flavor were as follows: For applesauce, a hot syrup made from one-third cup of sugar and three-fourths cup of water was added to 1½ pounds of peeled and cored apples which were then cooked in a covered pan as rapidly as possible until tender. For baking, cored, unpeeled apples in the proportion of 1 pound of apples to 5 level teaspoonsfuls of sugar were placed in a baking dish, covered, cooked in the oven at a temperature of 400° F. until nearly tender, and then removed from the oven and the cooking completed by means of the heat retained in the covered dish.

For eating raw, McIntosh was rated as best of the varieties tested. For baking, Rome, Cortland, and Northern Spy proved most satisfactory; for sauce, Cortland, Northern Spy, and Rhode Island Greening; and for pies, Rhode Island Greening, Northern Spy, Cortland, Jonathan, and Twenty Ounce. For use raw in salads, Cortland outranked all others because, in addition to other good qualities, it does not turn brown after it is cut.

Glazing, or surface cooking in a concentrated sugar sirup, is considered by the Massachusetts station to give a more attractive and palatable "baked apple" than baking in the oven in the conventional way. Although the method was used on a large scale in the selection

of apple varieties most suitable for commercial canning as whole baked apples, it appears to be equally practicable for small-scale use in the home. The glazing method as used in this study consists simply in cooking the cored but unpeeled apples in a 40-percent sugar sirup until tender, the time required varying from 5 to 10 minutes, depending on the variety, maturity, and size of the apple and the time it has been held in storage. Of the varieties tested, those relatively high in pectin and acid proved most satisfactory. These included Baldwin, York, Northern Spy, Rhode Island Greening, and Gravenstein, with preference for the first three because of their better color.

Another reason for recommending glazing in preference to baking is that the method was found to be less destructive of vitamin C, the losses averaging 44 percent in the glazed and 65 percent in the baked apples. The different varieties were not alike in the distribution of the vitamin between solid and liquid in the glazed apples. With Northern Spy and Rhode Island Greening equal amounts of vitamin C were found in the solid fruit and the sirup, while with Baldwin and York Imperial there was less, and with Delicious more of the vitamin in the fruit than the sirup. This difference is, of course, of no practical value provided the sirup or juice is not discarded. A good rule to follow with most cooked foods is to use the cooking liquid.

The vegetable most extensively studied for cooking quality at the experiment stations is the potato. It would be a boon to producers and consumers alike if simple reliable tests could be devised for checking the cooking quality of potatoes, particularly for mealiness and tendency to slough—one a desirable and the other an undesirable quality. The development of such tests and an understanding of what is responsible for desirable and undesirable qualities in potatoes are the objectives of several experiment station projects.

One of the most satisfactory tests for cooking quality in potatoes thus far proposed is the specific gravity test, which is being quite generally used. This test, as described by the New Hampshire station, consists in dropping uncooked potatoes in a series of salt solutions of different densities until a solution is found in which the potato just barely floats, which means that the density or specific gravity of the potato is the same as the known density of the solution. The New Hampshire investigators feel that the test to be reliable must be carried out on at least 50, and preferably 100, potatoes of a single lot. In the majority of samples tested, potatoes ranking from mealy to very mealy in cooking and judging tests had specific gravities in the uncooked samples of 1.08 to 1.1, while no sample classed as soggy or waxy had a higher specific gravity than 1.07. Potatoes judged excellent in general cooking quality were all in the groups having specific gravities of 1.09, 1.1, and 1.105. An average specific gravity of 1.093 was given a quality rating of 93. As thus tested 7 varieties of potatoes grown in two localities of the State had quality ratings as follows: Green Mountain 94 and 82, Smooth Rural 89 and 75, Russet Rural 84 and 81, Irish Cobbler 83 and 73, Warba 81 and 71, Chippewa 79 and 65, and White Rose 71 and 60, respectively. These values might be interpreted as showing that one of the two localities produced better potatoes than the other, and that only the Green Mountain grown in the better locality had really excellent cooking qualities. If the specific gravity test should continue to be satisfactory, specifications might be

set up in terms of quality ratings or, preferably, specific gravity, provided there were sufficient consumer demand. However, specific gravity probably does not tell the whole story.

The tendency of potatoes to slough badly on cooking is an unsatisfactory quality for which tests and also methods of checking are desirable, for sloughing results in considerable losses as well as a poor appearance in the cooked potato. The Colorado station attributes sloughing to the dissolving of the cell-cementing material, presumably pectin, in the cooking water. If there is sufficient calcium in the cooking water or in the potato itself, the cell-cementing material does not dissolve in excess and sloughing does not occur. Using potato varieties with high sloughing tendency (Irish Cobbler, Brown Beauty, and Russet Burbank), the Colorado investigators controlled sloughing simply by adding a small amount of a calcium salt to the water in which the potatoes were being cooked. Cracking and fracturing could be controlled only with much higher concentrations of calcium than necessary to eliminate sloughing. Calcium chloride in a concentration of 0.1 percent controlled sloughing and in concentrations up to 0.25 percent did not affect the mashing quality of the cooked potato. A concentration of 0.5 percent was required for good control of fracturing, but the potatoes became rather too firm to give the best quality on mashing. Another calcium salt, calcium sulfamate, gave equally good results and is recommended in preference to calcium chloride as it does not take up moisture from the air as does calcium chloride. A suggestion that may prove practical to prevent sloughing losses in the cooking of large quantities of potatoes as in institutions is to mix calcium sulfamate with ordinary table salt in the proportion of 1 part of the calcium salt to 8 parts of the table salt and add to the cooking water in amounts to season the potatoes.

The belief that the intercellular cementing material in potato tissue is pectic in nature has also been advanced by the New York (Cornell) station as the result of attempts along various lines to develop satisfactory objective tests for potato mealiness. Tests of the tensile strength (or resistance to breaking apart) of slices of potato tissue after cooking at different temperatures showed that the weakening of the cementing material takes place to a certain extent at any temperature between 45° and 75° C. (113° and 167° F.) with complete weakening at the higher temperature. As starch does not gelatinize at as low a temperature as 75° it was concluded that separation of the cementing material does not depend upon gelatinization of the starch. No difference was noted between soggy and mealy potatoes in the adhesion of the cells of the raw or cooked tissues. In line with this is the report from the Massachusetts station that extensive analyses for pectin of over 20 samples of mealy and soggy potatoes showed no relation between mealiness and pectin content. No differences were noted in the effect of heat on the permeability of the tissues of soggy and mealy potatoes as determined by measuring the resistance to the passage of an electric current through potato sections.

The next attempt of the Cornell investigators to determine what actually happens in the cooking of potatoes was to see if a softening of the tissues similar to that obtained in cooking could be brought about by chemical means and it was in this study that definite proof

was obtained that the intercellular cementing material in potatoes is pectic in nature and that doneness in cooking potatoes occurs when this material has been weakened to the point of separation of the tissue cells. Solution of salts capable of removing calcium from its combination with pectin softened the tissues, while solutions of other salts having no effect on calcium in combination with pectin did not. Moreover, the softened tissues were hardened by treatment with calcium chloride. These findings led the Cornell investigators to conclude that changes in the nature and amount of pectic substances in the potato during maturing and storage play an important part in the cooking qualities of potatoes and that the cation (mineral) content of the potato itself and of the water in which it is cooked is also of importance.

Meat.—Beef roasts and steaks are usually selected for quality on the basis of the United States grades of Choice, Good, Medium, and Common. To determine the extent of differences in quality of these grades in steaks as well as to extend the study of broiling methods noted in the 1938 report, home economists of the Missouri station broiled pairs of 1-inch porterhouse steaks of U. S. Choice, U. S. Medium, and U. S. Common grades at constant temperatures of 175° and 200° C. (347° and 392° F.) to an internal temperature of 58° C. and also pairs of 1-inch thick steaks of U. S. Choice, Good, and Medium grades and 1½-inch thick steaks of U. S. Common grade at temperatures of 200° to 250° to the same internal temperature. In all cases the steaks were turned when the internal temperature reached 44°. Highly significant differences in palatability of the different grades of steaks were found except for the U. S. Choice and U. S. Good which were equally palatable. The broiling temperature of 175° proved too low to brown the steaks sufficiently, and of 250° too high, in that the steaks cooked unevenly, were somewhat burned, and had greater cooking losses. The steaks broiled at 200° were attractive in appearance and scored high in palatability.

Not only grade but cut and class of beef have an effect on palatability. This has been shown by the Minnesota station in comparisons of the juiciness, tenderness, cooking losses, and palatability of roasts from three cuts—eleventh-twelfth rib, bread-and-butter cut, and round—of six steers graded High, Medium to Good, and seven cows graded Good. All of the cuts were roasted at a constant temperature of 150° C. to an internal temperature of 58°. As was to be expected, the round of beef ranked lower in tenderness and palatability and higher in cooking losses than the other two cuts. In juiciness there was no marked difference for all three cuts and in tenderness for the rib and the bread-and-butter cut. The rib roast showed the lowest cooking losses of the three. No differences could be detected between corresponding cuts from Medium and Good grade heifers except that the rib roast of Medium grade contained more moisture and less fat than that from the Good grade. In practically all respects, but particularly in flavor and aroma, the cuts from steers ranked higher than those from cows—a point to remember in selecting beef for highest quality.

Frozen storage.—The newest and, in some localities, the most popular method of preserving home-produced meats, fruits, and vegetables is by freezing and storing in freezer lockers. The rapid increase in

the practice of this method of preservation has tended to outstrip research on the many problems involved. However, a number of the stations are now devoting much attention to research in this field. In tests conducted by the Iowa station on retail cuts of beef and pork frozen at or near 0° F. for 8 hours and stored at temperatures below 15° it was found that the length of time which beef would retain acceptable palatability depended on the grade of meat and the amount of surface exposed to drying. The higher grades kept more satisfactorily in freezer storage with less shrinkage and a higher palatability score than the lower grades. The lower shrinkage of the higher grades was attributed to the additional fat covering the lean. Similar protection of the lean in pork cuts was afforded by the fat, but the fat in pork cuts tended to become rancid in a fairly short time. Tests by the Minnesota station showed a significant undesirable change in the flavor of the fat of pork-loin roasts in as short a time as 4 weeks. Consequently surface fat should be removed as much as possible in preparing pork roasts for the freezer locker but retained on the beef roasts. Wrapping the roasts in two layers of paper is recommended by the Iowa station as a help in prolonging the time of satisfactory storage.

In freezing poultry the question arises as to whether it is better to chill the birds overnight before freezing or to freeze them within an hour or two after killing. A comparison at Iowa State College of the two methods showed that with White Plymouth Rocks the birds chilled overnight before freezing were more tender than those frozen within 2 hours after killing but with Buff Orpingtons no differences in tenderness with the two treatments could be detected. Juiciness and general palatability except for tenderness were the same with both treatments.

For the farm family planning to make use of freezer-locker space to preserve some or all of the home-grown fruits and vegetables formerly canned for the winter supply two problems are uppermost. The farmer needs to know which of the types and varieties he can grow are best adapted to freezing. The housewife needs to know the best methods of preparing these home-grown foods for freezer-locker storage. Information on both points is already available from a number of sources and studies are in progress at several of the stations to meet the many requests for information on fruits and vegetables especially adapted to local conditions.

A publication of the Tennessee station (Bul. 168) contains information, secured during an extensive survey of the frozen fruit and vegetable industry and freezer-locker installations throughout the country, on proper temperatures for freezing and storage, the selection of containers, general methods for preparing the materials to be frozen with special directions for fruits and vegetables, and the cooking and serving of frozen foods in the home.

A mimeographed Department circular (B.C. and S.), representing the joint contributions of the Seattle Frozen Pack Laboratory of the Department and the Oregon station, contains useful information of a general nature on the preservation of fruits and vegetables for freezing with lists of the varieties and types common in the Pacific Northwest which are best adapted to freezing. The desirable varietal qualities of the fruits and vegetables included in the list are described

with directions for harvesting, handling, and preparing the material for freezing and suggestions for the most suitable types of containers and methods of packing.

The North Dakota station has summarized available information from various sources on types and varieties of fruits and vegetables suitable for small-scale freezing and is now studying varieties particularly adapted to conditions in the State. The Mississippi station has published a list of varieties of Mississippi-grown snap beans, lima beans, and beans best suited for freezing with specific directions for their treatment.

With all the emphasis that is being given to varietal differences there may be a tendency to forget that certain factors which affect quality in cooked or canned fruits and vegetables, such as freshness and the proper stage of maturity, are equally important for freezer storage. The cooking properties of frozen vegetables as well as their appearance after freezing must also be considered. Extensive studies have been conducted by the Washington station, working closely with the Seattle Frozen Pack Laboratory, on the cooking quality of green peas preserved on a commercial scale by the frozen-pack process. When the shortest possible cooking periods were used, steaming and waterless cooking preserved the natural flavor of the peas better than boiling in water, but with slight overcooking a strong flavor developed, especially with the waterless cooking method. Peas cooked in water collapsed less than those cooked without water. Differences in the maturity of the peas when picked produced greater changes in the texture of the cooked peas than did differences in variety.

Freezing, even more than canning, accentuates the poor as well as the good qualities of the original food. When foods are prepared in the home for freezing the housewife can safeguard the quality of the product by care in the selection and preparation of material. In using commercially produced frozen foods she has only the appearance, flavor, and (for vegetables) the cooking quality of the product as a guide. However, according to the New York State station, it is possible in the laboratory to judge the quality of most frozen vegetables by certain tests. One of these is the bacterial count. A count under 80,000 per gram of the material is considered by the station to show that the product had been blanched at a high enough temperature to kill practically all of the bacteria on the surface of the fresh vegetable, and that all of the processes followed during freezing, storage, transportation, and marketing had been carried on under such conditions as would prevent contamination of the product or multiplication of bacteria that might have been present. Careless handling at any time from preparation through marketing would give a final bacterial content of at least 100,000 or possibly as much as 200,000 or more per gram.

The second test proposed is a chemical test for the enzymes known as catalase and peroxidase which are normally destroyed in the blanching process as a means of preventing the development of off-flavors and loss of color. If neither the catalase or peroxidase activity of the frozen vegetables exceeds 1 percent of the normal activity of the unblanched vegetable, it is a sign that the blanching has been insufficient and the product will have a poor flavor and color if it is not kept at a very low temperature. The third test is the determination of

the vitamin C content of the frozen food. A normal or high vitamin C content is considered good evidence that the vegetable was not overmature when harvested and was properly handled during the necessary processing before freezing, and that the frozen product was stored at a sufficiently low temperature. This test does not imply that there are no losses in vitamin C during the freezing of vegetables but that these losses should not exceed definite limits. Values considered by the station as normal for certain carefully handled frozen vegetables are peas 17 mg. per 100 gm., lima beans 18, spinach 50, sweet corn 8, and snap beans 14 mg. per 100 gm.

Consumer demand for standards for frozen vegetables might make possible the adoption of specifications based upon these or similar tests. In the meantime the few figures just given, although not absolute, are useful in showing the relative richness in vitamin C of different frozen vegetables, supplementing the data given in an earlier section.

Canning.—Frozen storage of foods has by no means supplanted canning either as a commercial or home industry. The inevitable competition between the two methods involves many factors of which cost at present favors canning. The greater resemblance of frozen than canned food to the original material in appearance and flavor is resulting in a reexamination of canning methods for possible improvement. Suggestions along two lines have been made by the New York State station with commercial canning in mind but with possible application to home canning. One of these suggestions is that in canning tomatoes of high acidity, and highly acid fruits such as cherries, plums, peaches, and apples, lower temperatures may be followed than heretofore recommended. In suggesting this possibility the station points out that the canning industry is primarily based on the efficiency of the heat treatment to prevent spoilage, and in the interest of safety in this respect unnecessarily high temperatures may have been adopted for certain foods. Studies already made by the station on acid fruit juices, such as apple, grape, and rhubarb, indicate that this is the case, but more information is thought to be needed on the time and temperature of processing for various fruits and vegetables.

The other suggestion of the New York State station concerns a constituent of fruit and vegetables that has already been discussed in connection with the cooking quality of potatoes, namely, pectin. The addition of small amounts of suitable calcium salts to certain fruits and vegetables before canning is suggested as a means of making the tissues firmer and more like the raw material by uniting with the pectin and thus holding the tissues together. For some products this would be a disadvantage which is illustrated by the well-known unsatisfactory hardening of peas and corn cooked in hard water. On the other hand, with a vegetable such as tomatoes or a soft fruit such as peaches, it would be a decided advantage to have the canned product resemble the raw in firmness. This has been accomplished at the New York State station by the simple addition of as little as 0.05 to 0.1 percent of calcium chloride to tomatoes before canning and at the Colorado station with peaches in a similar manner. Preliminary tests at the New York State station have also shown like procedures to be useful in the freezing of fruits. If the calcium salt is added to the fruit long enough before freezing for the calcium to diffuse through the entire tissue, the natural structure of the fruit

is preserved and with such fruits as apples and peaches browning on defrosting is prevented. The use of calcium is also suggested in jelly making for fruits that contain pectic acid but insufficient pectin.

While chemists are introducing new canning methods, physicists and bacteriologists are continuing to help in the control of standard methods. The attention called by the Nebraska station to frequent inaccuracies in the pressure gages of steam pressure cookers, as noted in the 1938 report (pp. 154 and 155), has resulted in the checking and correcting of many gages throughout the country with presumably a lessening of spoilage of nonacid foods canned by pressure-cooking methods. An examination by the Arkansas station of a number of samples of spoiled home-canned products showed that inaccurate pressure-gage readings had been the cause of spoilage in several instances. Seven of twelve gages checked by the station were found to be very inaccurate and to have been responsible for under-processing. Other samples were spoiled from leakage due to the use of worn or cracked rubber rings or bent covers and from food particles between the jar lip and ring. From a can of flat-sour peas a heat-resistant organism was isolated that had caused spoilage on storage at a rather high temperature. Another cause of spoilage was the use of too large containers for products with low heat penetration. In this instance spinach had been canned in gallon jars. It is recommended that for such foods no larger containers should be used than No. 2 tins or pint glass jars.

Meat-canning methods are being reinvestigated for a possible revision of techniques, particularly time and temperature of sterilization. Bacteriologists of the North Dakota station are checking the rate of heat penetration in meat canned in glass by the pressure-cooker method. Tiny glass ampoules of heat-resistant bacterial spores were imbedded in the center of the meat-packed jars. During the processing at 15 pounds' pressure, which was continued for various periods of time, the rate of heat penetration was comparatively slow. An average of 30 minutes was required to reach 100° C. Although complete sterilization was never obtained, bacteriological examination of the jars immediately after processing showed that the organisms, which included the one causing botulism, had been killed in most cases. The possibility that slow-developing spores might still be present could not be tested until after the cans had been held in storage for some time. In similar studies at the Texas station, ground beef was inoculated directly with spores of a strain of the botulism organism and processed at 15 pounds' pressure for 1 hour in tin cans of two sizes. In tests made after 4 weeks there was no evidence of toxins or live organisms, but since the exact heat resistance of the spores used in the inoculation had not been tested definite conclusions are awaiting further work.

PREPARATION

Food preparation, through research, is changing from an art to a science. New discoveries and inventions necessitate new methods, revolutionizing old processes. Adjustments in recipes formerly made by rule of thumb are now yielding to mathematical formulas. Among the food-preparation problems receiving attention at the experiment stations during the year were altitude cookery, the use

of lard and its hydrogenated compounds as shortening agents and in frying, and the use of various stabilizers and emulsifiers in foods.

Cake making at high altitudes.—The altitude laboratory of the Colorado station, mentioned in earlier reports, has made possible controlled studies of cake making at different altitudes with the establishment of correct formulas and recipes for any altitude. Practical application of this work has been made in the dining cars of one of the transcontinental railroads in whose high-speed trains adjustments for different altitudes have to be made from one meal to another. The earlier work of the Colorado station on angel food cake has been extended to the more complex formulas for whole-egg sponge cake and whole-egg butter-type cakes with the general conclusion that, contrary to popular opinion, cakes baked at high altitudes need not be inferior, but may be superior to cakes baked at low altitudes.

As is well known, water boils at a lower temperature at high altitudes than at low. In cake baking the temperature within the batter is never higher than the boiling point of water unless the cake is over-baked and begins to burn. The higher the elevation the lower is the final temperature within the cake and the longer is the time required to reach it. The slower process makes the cakes more tender, in fact so tender that alterations have to be made in the recipes.

In the earlier work at the Colorado altitude laboratory on angel food cake the adjustment in ingredients considered most satisfactory with increasing altitude consisted in decreasing the amount of sugar until at very high altitudes the adjusted recipe contained almost no sugar. In the more recent work on whole-egg sponge cake and butter-type cakes it has been found possible to keep the sugar constant by increasing the proportion of liquid (egg and milk) to sugar. At sea level the amount of egg that can be used even in butter-type cakes without making the cake tough is rather small, but as the altitude increases the greater tenderness of the cooked egg permits the addition of more eggs without the danger of toughness. As a result the cake, with its higher egg and milk content, has an increased nutritive value and retains the sweetness characteristic of cake. With the extra liquid there is also less tendency for high-altitude than low-altitude cakes to dry out on standing.

The effect of egg quality on the properties of various cakes has also been studied in the Colorado altitude laboratory with the finding that the weight of the firm egg white is an excellent index of the behavior of eggs in cake batters, for the greater the weight the larger is the volume of the butter-type cake. Eggs of poor quality, in which the white is not firm, and dried eggs give a more crumbly product of smaller volume than eggs with firm whites. By slightly increasing the egg content of the batter and at the same time maintaining the liquid content constant, both volume and tendency to crumble are corrected. The ratio of yolk to white also has an effect on the properties of cakes. When the liquid content of the cake batter was kept constant and the proportions by weight of egg yolk and egg white were varied it was found that a decrease in the yolk tended to decrease the volume of the cake more than a decrease in the white.

With quality depending so much upon the proportion of ingredients, particularly the liquid to sugar ratio, it is readily seen that unless great care is taken failures will result from changes in these propor-

tions. With eggs varying in size and even in yolk to white ratios, with shortening and flour (even when sifted) varying in the weight of like volumes, and with measuring devices not divided into sufficient fractional parts for the slight alterations necessary, it is difficult to get the right proportions by volume measurement and number of eggs, and weighing the ingredients becomes almost necessary. The Colorado investigators say that—

Until the housewife is willing to adapt herself to measurement by weight, it will remain difficult to obtain results that approach uniformity at high altitudes. With weight measurements cakes superior to those produced at low altitude are easily obtained.

However, for those who do not have balances, or prefer to continue with the older method, the Colorado station investigators have worked out formulas of the ordinary type that will give fairly satisfactory results.

The effects of the quality and nature of the ingredients of cake mixtures are problems entering into successful cake making at any altitude. Probably many a failure with a tried and true recipe is due to the difference, noted above, in egg size and ratio of yolk to white. The type of shortening agent is another factor requiring some adjustments either in proportions of ingredients or in method of mixing.

The use of lard as a shortening agent for cake as well as for pastry is being encouraged in sections of the country where lard is more available than other shortening agents. Successful cake making with lard involves chiefly changes in technique in mixing the ingredients. In studies at the Nebraska station three methods of mixing were developed for making cakes by the butter-cake formula but replacing the butter with 70 percent by weight of lard, increasing the sugar content 10 percent and the liquid 15 percent, and substituting 22.4 percent of cornstarch for general-purpose flour. The hot-lard method, which is a variation of the muffin method of mixing, proved satisfactory for cakes with soft or melted lards kept without refrigeration. The single-stage method, by which all ingredients are mixed together at one time, was also satisfactory for soft lards. The cornstarch method, which is a modification of the sponge-batter method, was judged more desirable for use with firm than with soft lards. The flavor of rancid lard produced by poor storage conditions was masked by both the hot-lard and cornstarch methods of mixing.

In a comparison by the Iowa station of the value for plain cakes of a number of shortening agents the method of combining the ingredients was found to be one of the most important factors in producing cakes of desirable quality and palatability, particularly when lard was the shortening agent. Methods in which the egg is added to the milk or added last, either with or without a portion of sugar, to the batter, very greatly improved the quality and palatability of cakes made with oils, and to almost as great an extent those made with lards. Even cake made with butter usually ranked higher when the egg was added last than when added to the creamed mixture. Of all the methods tried, the conventional sponge in which one-half of the sugar is beaten into the eggs to form a light fluffy sponge and folded into the cake batter last gave the best results.

Doughnuts.—This type of dough mixture cooked by deep frying was studied by the Wyoming station for the possible effects of high

altitude (the station being at an elevation of 7,200 feet) and of different types of fat. A complicating factor was the lack of standard sea-level recipes for doughnuts, as will be seen from the reported analyses of 25 low-altitude household formulas. On the basis of 100 parts of flour the ranges in proportions of the other ingredients were sugar 17 to 59 parts, whole eggs 10 to 28, milk 36 to 55, fat 2 to 12, and baking powder 2 to 7 parts. Doughnuts made at the station from one of the sea-level recipes were very poor, showing a tendency to crack with high absorption of fat. Fairly satisfactory results were obtained using half hard-wheat and half soft-wheat flour and for every 100 parts of the flour 40 to 43 of sugar, 16 to 20 of whole eggs, 43 to 53 of milk, 2 of fat, and 1 to 1.8 parts of baking powder. It is difficult to compare these proportions with low-altitude recipes because of the wide variation in the latter. The quantities of sugar, milk, and eggs are between the minimum and maximum quantities found in the low-altitude recipes, fat the same as the minimum, and baking powder less than both and very much less than the maximum. The increase in liquid (milk and eggs) is in line with the Colorado cake work. The proportion of yolk to white was also found to be of some importance. Whole eggs tended to make the doughnuts tough, while with too high a proportion of yolk to white the doughnuts became too short and cracked open. Good results were obtained with eggs in the proportion of one-third yolks to two-thirds whole eggs.

The smoking points of the various fats used by the Wyoming station were approximately the same as reported for low altitudes, but the temperatures frequently recommended at low altitudes (350° to 400° F.) proved too high. Doughnuts fried at 350° for 3 minutes were golden brown in color, at 365° for 2 minutes a deep brown, and at 390° for 1½ minutes a very dark brown. Under the same conditions of frying approximately the same amount of fat was absorbed for each of the different fats used—lard, corn oil, cottonseed oil, and a hydrogenated fat. Two percent more fat was absorbed at the highest than at the lowest temperature used, probably because of the broken surface at the high temperature resulting from too rapid an expansion. With repeated use the smoking points of the different fats were lowered considerably, but less with lard than with the others. These changes were accompanied by increases in acidity. After 12 hours' use in frying the acidity increases were not enough to cause disagreeable flavors in the doughnuts but after 18 hours the flavor of the doughnuts fried in lard and hydrogenated vegetable fats became slightly objectionable. Storing lard in a cool place and keeping it tightly covered are recommended as means of prolonging its frying life through preventing the development of rancidity.

In deep-fat frying studies at the Indiana station very little difference was found in the absorption of fat from various sources with one exception. Hydrogenated soybean lard (from hogs fed soybeans) was absorbed to a much less extent than nonhydrogenated soybean lard, commercial lard, hydrogenated lard, and hydrogenated vegetable fats.

Refrigerator ice creams.—A problem recently attacked in the food-preparation laboratories of the University of California was the production of refrigerator ice cream (frozen without stirring) having both a smooth body texture and a low fat content. The use

of whipped cream to incorporate sufficient air in the mixture and butterfat to prevent crystal growth and also the separation of the cream largely results in a product of high fat content. The plan followed in the study was to test various so-called stabilizers in a modification of the standard basic recipe containing, as far as possible, similar proportions of fat, milk solids, and sugars as commercial ice creams. Again pectin comes into the picture as a very useful food ingredient, for it proved one of the most satisfactory stabilizers, although giving the product a rather characteristic flavor. The best stabilizer of all was agar used in 0.2-percent concentration with from 12 to 15 percent of dried skim milk. Agar also proved the best stabilizer for refrigerator sherbets and agar or gelatin combined with mayonnaise for frozen fruit salads. Recipes for household use have been developed, including a vanilla ice cream with agar, pectin, or cornstarch; a maple ice cream with apple pectin; and a chocolate ice cream with citrus pectin.

NUTRITION

VITAMIN FUNCTIONS AND REQUIREMENTS

Food requirements are determined and expressed in terms not of actual foods such as meats, vegetables, fruits, etc., but of their essential constituents such as fats, carbohydrates, proteins, minerals, and vitamins. In recent years interest has centered largely in the last two of these constituents, particularly in vitamins, for it is still a scant 30 years since the existence of such a group was suspected. From the first, experiment stations have played an important part in the discovery and study of the vitamins. A comparatively new field of experiment station research has been the development and use of methods to determine the nutritional status of human beings with respect to vitamins and some of the other important food constituents.

Vitamin A.—Night-blindness tests, or (to use a more scientific term) dark-adaptation tests, as a measure of vitamin A nutrition continue to receive attention in a number of experiment stations. Although it is an accepted fact that night blindness, if eye defects are ruled out, is due to lack of vitamin A or carotene (the plant source of the vitamin), the expense and size of the most approved instrument for making the test, the Hecht adaptometer, has led to improvements in the technique for conducting and evaluating the test with the biophotometer (Pennsylvania station) or other instruments of similar principle on the market (Massachusetts station). A new instrument of simple construction has been developed at the Rhode Island station and given the name rhodometer, from rhodopsin, the scientific name for the vitamin A-containing pigment in the eye, otherwise known as visual purple.

An entirely new method of diagnosing vitamin A deficiency is being tested by the Florida station, namely, the differential leucocyte, or white cell, count of the blood. Working first with rats, the Florida investigators noted during vitamin A depletion and recovery characteristic changes in the number and size of the white blood cells as observed in blood smears under the microscope. Applying similar tests to human blood they found that subjects with obvious symptoms of vitamin A deficiency showed similar changes in their white blood cells to those of the vitamin A-deficient rats and in general responded

in a similar manner to large doses of vitamin A. Should this test prove to be specific, its simplicity will make it of great value, but further work in many laboratories is necessary to confirm the results and show the applicability of the test under all conditions. A comparison of the blood test with the biophotometer readings has already been made by the Florida and Georgia station investigators working together on a group of children in Georgia, with results indicating a fairly good agreement but with greater sensitivity of the blood test.

The B vitamins.—First and in some ways the most important of these vitamins is vitamin B₁, now known as thiamin. It is largely through research at several of the experiment stations that it has been definitely shown that this vitamin is required for the complete metabolism of carbohydrates and consequently that the requirement for vitamin B₁ is in direct proportion to the amount of carbohydrate (starch and sugar) in the diet. Reports furnishing definite proof of this with rats have been published during the year from the Alabama and Wisconsin stations, and the latter station has also shown this to be true of dogs. This proof, combined with similar results in earlier studies in other species, leaves no doubt that the higher the carbohydrate content of the diet the higher is the requirement for vitamin B₁. The Alabama station has also shown, in very delicate microscopic studies of the nerves of rats in various stages of vitamin B₁ deficiency, that a chronic mild deficiency in this vitamin B₁ is likely to produce more disastrous results than an acute deficiency. The acute deficiency produces severe neuromuscular symptoms which are readily relieved by the administration of large doses of the vitamin, but long-continued chronic deficiency may result in damage to the nerve tissues that cannot be cured no matter how much of the vitamin is given.

The announcement a year or so ago from the Wisconsin station that the well-known chemical compound nicotinic acid is a B vitamin responsible for the prevention and cure of pellagra was promptly followed by the successful use of pure nicotinic acid and some of its derivatives in the treatment of pellagra. An important byproduct of this discovery has been the proof that riboflavin, another of the B vitamins whose chemical nature is known, is essential for the prevention and cure of certain symptoms often associated with pellagra (chiefly soreness in the angles of the mouth) which do not respond to nicotinic acid. Thus one discovery leads to another, for it was not until nicotinic acid in the pure form had failed to cure all of the symptoms formerly attributed to pellagra that the specific effects of riboflavin deficiency in humans were recognized. Further work by the Wisconsin station has shown that foods containing only fair amounts of nicotinic acid are useless in the treatment of pellagra because the pellagrin is unable to digest the food sufficiently to liberate the nicotinic acid present. For the cure of diseases caused by lack of certain vitamins the use of concentrates of the vitamin in question or of the pure vitamin, if it is available, is often necessary, while for the prevention of the same diseases the right kinds of foods in abundance are usually sufficient. Continued study of the vitamin content of foods is needed from the standpoint of prevention of vitamin-deficiency diseases. Continued research leading to the isolation and synthesis of vitamins is needed from the standpoint of

knowledge of their function and their preparation in pure form for curative use.

An important discovery by the California station is that one of the B vitamins, not yet isolated but present in effective amounts in certain concentrates made from yeast, rice bran, and liver, may be a preventive of premature aging of certain vital organs. Lack of this substance in the diet of young pied (colored) rats was found to cause graying of the hair at an early age, loss of skin elasticity, deterioration of the adrenals and other glands and, in some cases, the development of leg ulcers. All of these old-age symptoms were rapidly cured by the administration of the concentrates mentioned or by injections of large doses of adrenal cortex extract. The effectiveness of the latter suggests that the unknown "antigraying" factor may be necessary for the proper functioning of the adrenal cortex.

Another of the B vitamins whose function is suspected but not actually known as yet is vitamin B₆, the lack of which is associated with a certain type of dermatitis known as acrodynia. Recent work by two groups of investigators at the Wisconsin station suggests that both vitamin B₆ and certain fatty acids are involved in the prevention and cure of the acrodynia. Possibly there is a connection between the two. The station is continuing attempts to identify the remaining unknown factors in the B complex.

Vitamin C (ascorbic acid).—Studies on guinea pigs at the California and Washington stations indicate that pure ascorbic acid is not equal in its protective effects to a corresponding amount of the vitamin furnished by orange or tomato juice. The difference noted by the Washington station investigators was not in the amounts of ascorbic acid in the blood and organs of the guinea pigs, which were alike for both sources of the vitamin, but in the tendency to hemorrhages in the joints—the real scurvy symptoms. These appeared in the animals receiving an amount of pure vitamin C which in the form of orange juice was completely protective. This suggests that it is wise to get one's vitamin C from natural foods rather than to take it as pure ascorbic acid.

Through two cooperative projects, one among three stations in the Northeast (Massachusetts, New York (Cornell), and Rhode Island stations) and the other among five in the Northwest (Washington, Montana, Idaho, Utah, and Oregon stations), considerable information has been secured on the intake and output of vitamin C by young people, chiefly college women. An elaborate investigation at the New York (Cornell) station of the vitamin C requirements of young people has continued along the lines described in the 1937 report (p. 149), and the same plan is being followed with a limited number of subjects in the Northwestern States noted above. At the California (Davis) station elderly people are being studied in a similar way with indications that in older people the cells use up vitamin C more rapidly than in younger people and that the requirement for vitamin C in old age may be greater than is now assumed.

The first detailed report of the New York (Cornell) station vitamin C-requirement study gives values for seven normal adults, five young women and two young men, of whom two required between 70 and 85 mg. of ascorbic acid daily to maintain tissue saturation, three between

85 and 100, and two more than 100 mg. daily. (A full glass of orange juice furnishes about 100 mg. of ascorbic acid.) When calculated in terms of body weight, these values amount to a range of from 1 to 1.6 mg. per kilogram (2.2 pounds) of body weight. In the three subjects already studied by exactly the same method at the Washington station, the requirement ranged from 70 to 90 mg. of ascorbic acid daily, or 1.2 to 1.8 mg. per kilogram of body weight. These values represent the minimum quantity of ascorbic acid, not for the protection of the body against scurvy or any visible sign of vitamin C deficiency, but for the complete saturation of the tissues. How necessary or advantageous it is to keep the body fully stocked with vitamin C has not yet been determined with certainty and is one of the reasons for a continuation of vitamin C studies such as are being carried on in so many of the stations in the hope of simpler and perhaps more dependable tests for vitamin C status and requirements. The efforts of the northwestern group are now being directed chiefly toward determination of the ascorbic acid content of the blood as a more simple measure of vitamin C status and requirements.

As a simple qualitative test for the status of vitamin C nutrition in children, the Maine station has found that the condition of the gums, whether inflamed or not, checks very well with the results of saturation tests for vitamin C. Five of six children with normal gums gave good response to the saturation tests, while 12 of 29 children with inflamed gums gave poor results. An increase in the number of children with inflamed gums from 7 percent in the fall to 25 percent of the same group in the spring showed that many of the children were receiving too little vitamin C in the winter months.

Vitamin interrelationships.—The problem of vitamin requirements is becoming more complicated with accumulating evidence of interrelationships among them, at least if experimental evidence with laboratory animals can safely be applied to human beings. At the California station the effect on rats and dogs of moderately excessive doses of vitamin D has been found to be more toxic than has hitherto been supposed, but an excess of vitamin A at the same time protects against the toxicity. If a diet is abundantly supplied with calcium and phosphorus there is less danger of toxic effects from excess vitamin D. From the Arkansas station likewise comes word that severe depletions of vitamin A render animals more susceptible to extratoxic effects of vitamin D. The Arkansas investigators have also observed that deficiencies in vitamin A, vitamin B, and riboflavin result in losses of vitamin C from various organs of the rat, an animal which does not ordinarily require vitamin C. Hyperthyroidism in rats also depletes the store of vitamin C and to a greater extent if the diet is deficient in vitamin B₁. However, these findings are not of as great concern to the housewife or dietitian in providing vitamins in the diet as to the clinician in prescribing vitamins as supplements to various clinical measures.

MINERAL REQUIREMENTS AND UTILIZATION

Calcium and phosphorus for bone and tissue development and maintenance, and iron and copper for hemoglobin formation in the blood are the mineral elements chiefly considered in judging the adequacy of

the diet. While food analyses give the content of these elements in different foods there still remain questions of the extent of their utilization in the different forms in which they are taken into the body, and the actual amounts needed for optimal nutrition, the state which cannot be bettered. These questions, particularly as applied to calcium and iron are receiving attention at the experiment stations.

Calcium.—The comparatively low availability of calcium in spinach in comparison with other green vegetables and calcium salts, as determined in feeding experiments on rats and by certain chemical tests, has been noted on page 191 and brief reference was made to calcium studies of the Illinois and Oregon stations with human subjects. A long-continued study of the Illinois station in which small groups of preschool children, five girls and five boys, served as subjects, led to some rather surprising conclusions. The finding that calcium was equally effective in milk and in dicalcium phosphate (the salt commonly recommended by physicians as a supplement to food calcium) was to be expected, but that only about 20 percent of the calcium from either source was utilized by the body was somewhat of a surprise in view of the fact that rats are capable of utilizing calcium almost completely. However, the smallest amount of calcium required for the highest retentions (intake minus output) in these children was quite a bit lower than the commonly adopted standards. In terms of milk, the Illinois investigators stated in their report—

Obviously if these children had been receiving a diet generous in vegetables (such as is usually recommended for children of their age) it is altogether probable that the addition of a pint of milk easily would have supplied enough calcium to meet the requirements.

As a preliminary measure these children had been given generous doses of dicalcium phosphate during a period of several weeks in order to make up for any deficiencies in the past and to start the experiment with a maximum storage of calcium. Thus the estimate of a pint of milk a day can safely be used only for children who are not low in calcium to start with. Commenting on the equal effectiveness of calcium in dicalcium phosphate and in milk, the Illinois investigators point out that except in the cases of children who are allergic to milk or for whom it is difficult to secure enough milk the use of a calcium salt either as a substitute for or supplement to milk—is economically unsound. Money invested in dicalcium phosphate buys only two nutrients, calcium and phosphorus, whereas money invested in milk buys a portion of almost all of the various nutrients required by the human body.

In another investigation at the University of Illinois a man was found to utilize the calcium in milk and in calcium gluconate equally well but, as in the case of children, only to the extent of about 20 percent. In estimating requirements for adults the criterion used was the quantity of calcium required for equilibrium, a balance between intake and output, rather than for storage. This requirement was met in the single subject studied by about 40 gm. of skim-milk powder furnishing 540 mg. of calcium in addition to about 195 mg. in the basal diet. The total calcium, 735 mg., amounts to about 9.2 mg. per kilogram (2.2 pounds) of body weight as the minimum calcium requirement for maintenance in an adult.

Iron and copper.—The function of iron and copper in the prevention and cure of nutritional anemia was discussed in the 1937 report (pp. 144, 145). Most of the experiment station research in this field has been carried out on rats on the assumption that human beings would respond in a similar manner. The Mississippi station has recently put this to the test by the simple means of feeding iron and copper salts to a man suffering from chronic anemia as the result of having taken all his life no other food than milk. The 3 quarts of raw milk a day, which he had been in the custom of taking, had apparently protected him against obvious symptoms of scurvy, but he had become incapacitated for work because of his anemic condition.

During an observation period of 6 weeks before treatment was begun the hemoglobin content of the blood of this subject averaged 3.7 gm. per 100 cc. as compared with normal values of about 14 gm. per 100 cc. The red blood cell content was also low. The treatment consisted at first simply in supplementing the milk diet with a solution of iron and copper salts furnishing 150 mg. of iron and 6 mg. of copper a day. Later, after improvement had begun, citrus-fruit juices were added to the diet to increase the vitamin C intake, and a cup of pot liquor two or three times a week for additional iron and copper. With no other treatment the hemoglobin content of the blood rose to 12.9 gm. per 100 cc. in 4 months and to 13.8 gm. in 6 months. Along with improvement in the blood picture there was such marked improvement in the subject's physical condition that he was able to work again.

The striking results obtained with this subject add weight to the belief based upon animal experimentation that a certain type of anemia is produced by lack of iron and copper and requires these mineral elements for the prevention and cure of the condition. Fortunately, copper is needed in such small amounts and is present in so many foods that for people on a mixed diet iron alone need be considered. Copper metabolism studies at the Nebraska station indicate that as small an amount of copper as 2 mg. a day is enough for maintenance and that larger amounts are stored for future use.

Iron-deficiency anemia among children may be a more serious problem than is generally supposed. Recent studies by the Florida station have shown that the condition may continue in a chronic stage without the appearance of easily recognizable symptoms until the hemoglobin has been reduced as much as 50 percent. Among nearly 900 school and preschool children tested by the Florida investigators, one of whom was a physician, 50 percent were definitely anemic as indicated by hemoglobin values and red-cell counts and 31 percent were on the border line. About 400 of the children were in a single county representing quite different soil and occupational types. The hemoglobin values for these children ranged from 4.35 to 14.05 gm. per 100 cc. In school districts on the coast, where fishing and general farming predominated, less than 5 percent of the children were anemic, in general- and truck-farming areas 15 percent, and in certain other districts as high as 60 percent were anemic.

An even higher percentage of women examined during pregnancy were found by the Florida investigators to be anemic. Hemoglobin values as low as 35 percent were frequently obtained. In all cases

routine iron treatment (sometimes with hydrochloric acid) raised the low values to normal.

As with most dietary-deficiency diseases, this type of anemia is more easily prevented than cured by foods rich in the deficient substance, in this case, iron (and copper). In the Florida study with children, the addition of iron-rich foods to the diet failed to bring the hemoglobin back to normal in 3 months when the anemia was severe, although iron salts corrected the condition in a much shorter time.

From an earlier study of the food consumption of boys and girls in agricultural high-school dormitories in Mississippi and preliminary blood studies in young men and women just after enrolling in colleges in the State, it has been concluded by Mississippi station investigators that the girls are more often below standard in various nutrients, particularly iron, than the boys. As it is now thought that the iron requirements of women are even higher than of men, it is particularly important that they should receive plenty of iron-rich foods in order to prevent the development of a condition that is so much more difficult to cure.

DIETARY HABITS AND INDICES OF NUTRITION

The adequacy of family diets is usually determined from records of food consumption during a period of time by calculating the quantities of the essential nutrients in the diets from the most reliable table of food composition and comparing them with the needs of the family, as estimated from existing standards. In a series of studies by the South Carolina station of the types and adequacy of farm-family diets in different sections of the State, the diets as thus calculated were given ratings of good, fair, or poor, according to the extent to which they met these standards. The second of these studies, in the Coastal Plains area of the State, has been completed and the results made available in a station bulletin (No. 319). Only 95 of the 214 white-family diets studied and 31 of the 183 Negro diets could be classified as nutritionally good, while 89 white and 71 Negro diets were fair, and 30 white and 81 Negro diets were poor. According to the report—

though lack of money and resources was responsible for many of the poorly balanced diets found in the South Carolina study, lack of knowledge and failure to plan well were equally evident reasons for having diets that were less than adequate.

As an aid to better planning and the selection of good diets, the amounts of some of the more common foods used per person per week in the diets of the different grades were pictured graphically in the bulletin. Studies of this type reported in easily understandable terms are of great educational value, for, as stated in an editorial comment on the bulletin in one of the newspapers of the State: "It is only when the population possesses knowledge of food values and the ability to plan well that their resources can be made to serve their needs."

Another method now coming into use for judging the adequacy over a long period of time of diets of certain patterns is to compare family food-consumption records with the nutritional status of the

individual members of the family. This is a costly, time-consuming method but well worth undertaking if personnel and funds for rather expensive equipment are available. The Pennsylvania station is conducting such an investigation by methods which have been discussed at considerable length in one of the series of Pennsylvania State College Studies (No. 4). Among the methods being used is the determination of the density of the bones as a measure of calcification by tracing the density in X-ray films of the bone from one fixed point to another with a recording microphotometer adapted by the Pennsylvania investigators for use with a photronic cell. The apparatus as modified is thought to have wide applications for bone and tooth density measurements.

Certain body measurements have long been used as one measure of nutritional status of children of different ages without much regard to possible regional or racial differences. The Texas station published during the year the final report (Bul. 567) of an investigation of the relative size, body build, and rate of growth of Mexican, white, and Negro children in the public schools of San Antonio. The differences among the three groups were such as to indicate very conclusively that growth standards for white children should not be used for Mexican or Negro children, although more studies are needed with standardized technique to determine the extent to which various factors affect growth of individuals of the same race in different localities and different races in the same locality.

The three regional cooperative projects dealing with various phases of the problem of nutritional status and requirements of young people, as noted in the 1937 report (pp. 142, 143) are continuing, with the accumulation of data on anthropometric measurements, basal metabolism, blood chemistry, dietary habits, and mineral, nitrogen, and vitamin C metabolism, which should be of considerable value in establishing more reliable standards of nutritional status and requirements—consumer problems of vital interest.

TEXTILES AND CLOTHING

Consumer preferences for articles of clothing and household textiles are receiving attention in experiment station research from the standpoint of household economics and budget planning and consumer information concerning quality. The latter involves laboratory tests to check the reliability of the information available.

Factors affecting consumer choice in the purchase of "silk" street dresses and yard goods were studied by the Minnesota station, with the conclusion that "reliable standards and dependable labeling are needed as guides to the quality of both workmanship and materials." Studies by the Missouri station, noted in a preliminary stage in the 1938 report, on consumer preferences for selected articles of clothing (house dresses, afternoon dresses, slips, and hose) and of household textiles (sheets, blankets, window curtains, and towels) have been completed with the analysis of nearly 3,000 returned questionnaires on clothing and 4,000 on household textiles. The majority of the participating women were from rural areas making their purchases in small towns and cities. For each commodity the information reported included, in addition to other items, demand for specific qualities, effect of income on practices with range in prices paid,

and difficulties encountered in buying and with wearing qualities. The difficulties encountered are more or less familiar to consumers, but their enumeration in the bulletins reporting these studies (Res. Buls. 300 and 301) may call the attention of manufacturers and wholesale buyers to certain practices that should be corrected. The price ranges noted should be of help to consumers in budgeting their expenditures for clothing and household textiles, although giving no indication as to the value received for the different prices spent.

The extent to which authentic information is available to purchasers of textile fabrics concerning the fibers (cotton, silk, and different types of rayon) of which the fabrics are composed has been investigated by the Kansas station through comparisons of the composition of the selected fabrics, as determined by laboratory tests, with the information as to composition available to the purchaser. A total of 268 fabrics, about equally divided between single- and mixed-fiber composition, was secured in 18 stores in 7 towns and cities of the Midwest. In many cases the fabrics were not labeled as to fiber content and no information could be secured from the salesmen. Among the fabrics that were labeled or concerning which the salesmen furnished some information, many more were described inaccurately than accurately. The inaccuracies were chiefly in the three types of rayon fabrics—acetate, cuprammonium, and viscose rayon.

The announcement was made in the 1937 report (pp. 152-153) of a cooperative textile project among several of the Northeastern States for the purpose of comparing performance during wear of fabrics used in the home construction of women's and children's garments with predicted performance from laboratory tests of the original material. All materials collected in the various States are sent to the textile laboratory of Pennsylvania State College where they are being analyzed by standard methods with improved equipment, including the newest model of twist tester to distinguish between various types of crepes, a flexometer to determine crease resistance, and a hydrostatic machine to determine waterproofing. By June 1, 1939, a total of 754 fabrics had been received at the laboratory, including 81 wool, 79 silk, 260 cotton, 244 rayon and rayon mixtures, 9 linen, and 81 miscellaneous mixtures. Comments at that time by the Pennsylvania workers were that "more accurate sales information on the probable durability of textile fabrics is needed by consumers."

THE HOUSE AND ITS EQUIPMENT

Kitchen planning.—The kitchen has received more attention than other parts of the house in agricultural experiment station research, for it is not only the place where the farm homemaker spends the greater share of her working hours but often the center of various other home activities in which all of the members of the family participate. In times past farm kitchens were planned without much regard for efficiency either in the saving of steps for the work to be done or in the planning of space for different types of activity.

The first and most important step in kitchen planning is the arrangement or rearrangement of work centers for greatest efficiency. The most recent experiment station contributions along this line have been from the New York (Cornell) and Oregon stations. Unfortunately, no one standard for kitchen size, shape, and arrangement can be set up. Often the only possible change in existing kitchens is in the rearrange-

ment of working surfaces and equipment and the provision of more convenient and adequate storage space. The latter is particularly necessary when the important step is taken of abandoning the pantry because of its inconvenience for storing equipment and materials in everyday use.

Special attention has been given in the New York studies to kitchen rearrangement and procedures for making existing space in kitchens of odd sizes and shapes more convenient through shelves, drawers, and hanging racks adapted to the various utensils and equipment for which space must be provided. Useful suggestions with photographs of actual arrangements in New York State home kitchens and diagrams of various space-saving devices are given in one of the series of Cornell Bulletins for Homemakers (No. 398).

At the Oregon station emphasis has been given to the equipment, arrangement, and minimum dimensions of kitchens that will make adequate provision for the needs of farm families in the section of the State in which the work was done. Conferences were held with a number of farm homemakers concerning the various uses to which their kitchens are put and the equipment, large and small, for which space must be provided. On the basis of the information thus secured and a number of laboratory tests, plans were developed to meet various situations. These have been published in a technical bulletin of the station (No. 356) and more briefly in a circular (No. 131) which includes working designs for cabinets, floor plans, minimum dimensions for free floor spaces, and descriptions of the centers needed in the average farm kitchen for food preparation, dining, ironing, planning, and child care and play.

Floor finishes.—The covering of the kitchen floor, the finishing of the other floors, and the general care of the woodwork throughout the house are problems which are receiving attention at the Rhode Island station and to some extent at the New York (Cornell) station. A motor-driven apparatus has been devised and is in use at the Rhode Island station for testing the serviceability of various floor finishes. The work is still in progress, but a mimeographed publication (Misc. Pub. No. 3), giving practical information, based on the results thus far obtained, for the guidance of homemakers in the choice, application, and care of finishes, has been issued. Special emphasis is given to penetrating seal finishes for wood floors, and water-emulsion waxes for other wood and linoleum coverings with simple household tests for quality in the latter. The Cornell study is dealing for the present with the durability of, and suitable finishes for, linoleum of the felt-back type.

Kerosene stoves.—The Maine station study on kerosene stoves, noted in the 1937 report (pp. 153-154) from preliminary work, has been completed and the results have been made available in a station bulletin (No. 394) in which the material is so arranged as to be of service to other investigators, teachers of household equipment, extension workers, and manufacturers. Prospective purchasers and users of kerosene stoves may find more useful an extension bulletin (No. 251) which gives much practical information based upon the station study, through answers to a series of questions such as any housewife buying or using a kerosene stove might ask.

Gas stoves.—Further studies by the Nebraska station of selected types of gas stoves have resulted in somewhat more definite specifica-

tions (Res. Bul. 111) for optimum requirements of the cooking tops and ovens than were noted in the 1937 report (p. 154). Special emphasis was given to the specification that the cooking top burner assemblies should produce no carbon monoxide. Two of the six stoves tested did produce more carbon monoxide than allowable under the standards of the American Gas Association Testing Laboratory and in both cases the cause was found to be the inability of the burners to handle properly higher gas rates than 8 cubic feet per hour. In view of the grave danger involved in carbon monoxide production, this point should be thoroughly investigated with reference to the prevailing gas pressure when purchasing a gas stove. Knowledge of the burner capacity is helpful not only for top burners but also for oven burners inasmuch as burners made for a larger capacity than needed to heat the oven cannot maintain a low enough temperature to meet all baking needs.

Consumer demand for such specifications as have been developed by the Maine station for kerosene stoves and the Nebraska station for gas stoves will do a great deal to improve the quality and uniformity of the equipment. Similar studies of some of the newer types of electric equipment are also being carried on at several of the stations.

Electric mixers and beaters.—A progress report from the Indiana station on small electric mixers states that the greatest difficulty in the use of mixers as now manufactured is not to overmix the product. Most of the small mixers thus far tested by the station can be used to mix both sponge and butter cakes. In general the best results are obtained with recipes requiring considerable mixing. In creaming, maximum volumes are obtained at the lower speeds. As a result of conferences of research workers in equipment from the experiment stations and the Bureau of Home Economics some co-operative work on various types of equipment is being undertaken. One of the first examples was a cooperative arrangement between the Iowa and Nebraska stations on electric mixers. This involves certain changes in equipment to be made at the Nebraska station and tested in a practical way at the Iowa station. The work at the Indiana station is now being made a part of this cooperative project.

Electric roasters.—This is a still newer piece of electric equipment to receive attention in experiment station research at Iowa and Virginia. The work is in the early stages and it may be some time before standard specifications can be set up. Nevertheless, certain conclusions drawn by the Virginia station after a rather complete examination of six of the most popular electric roasters now on the market may be of value to the housewife who wonders whether she would be justified in buying this piece of equipment. The Virginia station reports that the results thus far obtained indicate that all of the roasters are slow to preheat and must be turned on a considerable time before heating, but the thermostatic control is about the same as in the electric range and the current consumption no greater or even a little less. In general, according to the Virginia investigator—

in small families the roaster can be used for all of the cooking but for larger farm families, especially where a wood or coal range is maintained, the roaster must be considered a supplementary appliance for cooking. It is particularly useful in the summertime when heat from the stove is detrimental, also where electric cookery is desired and the high-priced electric range cannot be afforded.

Cooking utensils.—One important and often neglected item in the use of any cooking equipment, whether it be a kerosene stove or an electric roaster, is the effect of the material of which the cooking utensils are made. According to investigators at the Maine station who are studying the effect of method of heat application on flavor and texture of baked foods—

the cooking of foods is not solely a problem of heating the mass as quickly as possible. On the contrary, a definite rate of heat absorption, not too fast or too slow, is necessary to bake certain foods, particularly batters and doughs.

If foods are to be baked satisfactorily in glass pans, the oven temperature should be lower than for metal pans to obtain the same rate of heat absorption. The extent to which the temperature should be lowered depends on the amount of material to be heated. With very small amounts the same temperature can be used for both glass and metal pans, but as the amount increases the temperature satisfactory for tin should be correspondingly lowered.

FAMILY ECONOMICS AND HOME MANAGEMENT

The economic problems of the family in rural homes include not only the management of the family's material resources but often the management of the time of the homemaker. For wise management of finances it is advisable to take into consideration the farm enterprise as well as the home, and for this reason farm economists and home economists are beginning to get together in joint studies of the factors affecting the expenditures of farm families. The problem of securing a greater cash income as well as a comfortable living from the farm is a serious one in sections of the country where the farm income is meager and the opportunities for gainful employment for the younger generation are slight. This problem is also receiving attention in experiment station research.

Family expenditures.—Reports from several of the stations on expenditures of farm families are of special interest to the families from whom the records were obtained and others in the same localities and of general interest in the comparisons they afford of the percentage expenditures for the different items that make up family living. As an illustration, reports of family-living studies in Arkansas, Maryland, and North Dakota showed very similar proportional allotments of the family income to clothing—14.1, 15, and 15.2 percent, respectively—but those for food were quite unlike—23.2, 41, and 29.2 percent, respectively.

The rather uniform percentage expenditures for medical care, 5.7, 7.7, and 5 percent, respectively, are of interest also in comparison with corresponding figures obtained in the first two of a series of studies by the Arkansas station on sickness and medical care among different population groups in the State. Data from the first study of white families in the Ozark section were given in the 1938 report (pp. 156-157). The report of the second study among the Negro population in a Delta area of the State as published in a station bulletin (No. 372) shows some interesting contrasts. The white families in the first study used on the average 6.5 percent and the Negro families in the second study 4.3 percent of their cash expenditures on medical care. Thus in five different studies in three States the percentage of total expenditures (which varied widely) used for medical care varied

within the comparatively narrow limits of from 4.3 to 7.7 percent. The most striking difference in proportional expenditures for various health services in the two Arkansas studies was in unprescribed medicines, which amounted to about 20 percent of the total health expenditures for white families and 42 percent for the Negro families.

Increasing cash incomes of farm families.—One of the socioeconomic problems of farm families in many sections of the country is the lack of cash not only for the bare essentials of family living but for the little extras needed, especially by young women at home on the farm. Opportunities for cash incomes for farm women include full-time jobs in rural communities near larger cities, home industries in localities with tourist trade, home demonstration and farm markets, local industries in rural areas, and no opportunities in many sections. A study by the Rhode Island station of methods by which married women on full-time jobs manage to carry on their homemaking activities showed that labor-saving equipment, help from other members of the family, and the greater use of commercial services for foods and laundering make it possible for these women to carry on successfully the double responsibility to home and outside work when it is necessary to supplement the husband's inadequate income. In spite of the fact that nearly 60 percent of the women reported they were working for necessities, 62 percent said they enjoyed their work and would not like to give it up. Thirty-eight percent felt that the pressure of need made their job decidedly necessary, but would gladly give it up if it were financially possible.

In Arkansas station studies cash receipts of home demonstration and souvenir markets were found to contribute a considerable proportion of the cash income of some rural families. The median proportion of the family income received from the home demonstration markets was 25.4 percent. Handicraft sales contributed an average of 21.6 percent of the cash income of families engaged in this enterprise.

In Mississippi a greater cash income for rural girls is considered to be a community problem. In a random sample of white women in rural areas of two poor agricultural counties of the State the Mississippi station found that 93 of 178 single women 16 years of age and over had had almost no gainful work during the year of study. Among this group were 63 between the ages of 17 and 35 years of whom 37 had no cash earnings and 26 small earnings averaging \$28 a year. It is pointed out that the brothers of these young women are generally given a crop to work, with the experience and benefit of handling a little money of their own, but the girls remain in a status similar to that of children in the family.

FAMILY RELATIONSHIPS

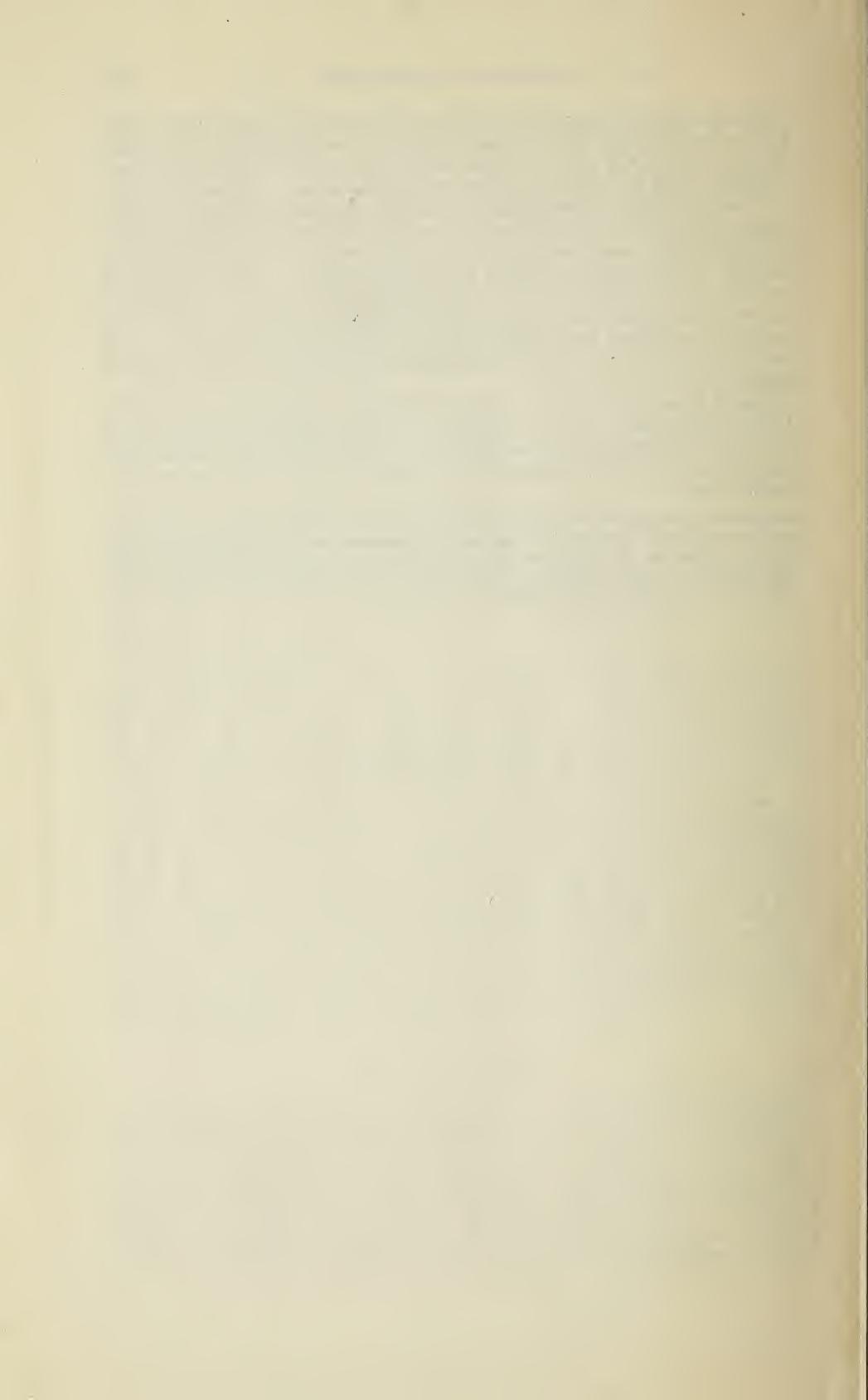
Research in this field is much needed in rural communities, but until recently has been given little attention in experiment station research. A beginning has been made by the Nebraska station in a study of personality development in farm, small town, and city children. The reports of this study (Res. Buls. 106 and 114) have brought out differences in home settings (farm, small town, and city) with respect to their effect on personality development of the children growing up in them. These reveal certain weaknesses in the

farm setting as compared with the small town, but particularly with the urban setting. In scholastic aptitude as indicated by the Otis I. Q. tests the city group ranked highest and the farm group lowest for both boys and girls. In social relationships, as shown by tests of resourcefulness in group situations and ethical judgment, the farm group ranked lowest, with the city and small-town group about equal. The differences were almost wholly with the girls and are attributed in part to fewer opportunities for social contacts. The farm group ranked higher than the town group but lower than the city group in personal adjustment and independence of decision concerning personal problems and difficulties and higher than the town group but not significantly different from the city group in attitude toward home life.

These intangible problems of family living and particularly of the best development of the children in rural homes are even more difficult to meet than the tangible "consumer problems" which have been discussed. The Nebraska investigator, however, expresses the belief that—

as parents and prospective parents are led to realize the importance of congenial, confidential, and affectionate relationships between parents and children, and of the utilization of family leisure in wholesome and stimulating joint recreational activities there should result also a rise in the general level of personality adjustment of rural young people.





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